

**Monsanto**

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U.S. EPA, REGION V  
WASTE MANAGEMENT DIVISION  
OFFICE OF THE DIRECTOR

December 23, 1987

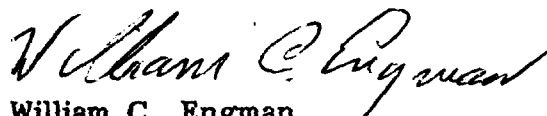
Mr. Basil Constantelos, Director  
Waste Management Division  
Region V  
U.S. Environmental Protection Agency  
230 South Dearborn Street  
Chicago, Illinois 60604

Dear Mr. Constantelos:

Attached is the response prepared by Geraghty & Miller, Inc., to the IEPA/USEPA comments regarding the Monsanto Groundwater Assessment Report.

Monsanto and the Sauget Sanitary Development & Research Association (SSDRA) have agreed to your request to consolidate information and have requested Geraghty & Miller, Inc., to prepare combined groundwater flow and contamination maps of the two properties. These maps will be forwarded to you shortly.

Sincerely,

  
William C. Engman  
Environmental Superintendent

/bjj  
Attachment

cc: Mr. Bill Child, IEPA



December 22, 1987

VIA FEDERAL EXPRESS

Mr. Warren Smull  
Monsanto Company  
500 Monsanto Avenue  
BK Building  
Sauget, Illinois 62201

Re: Response to IEPA/USEPA Comments Regarding the  
Monsanto Company Ground-Water Assessment Report

Dear Mr. Smull:

We have prepared the following responses to the Illinois Environmental Protection Agency (IEPA) and the U.S. Environmental Protection Agency (USEPA) comments on the Geraghty & Miller, Inc. report regarding the ground-water assessment for the the W.G. Krummrich facility in Sauget, Illinois. The agencies' comments appear in letters from the IEPA dated June 30, 1987 and August 3, 1987. Their comments have been divided into six sections as follows: Introduction, Concerns on Ground-water Flow, Impact of Contamination, Effect of Contamination, Comments from IEPA Letter Dated August 3, 1987, and Remedial Measures. For convenience, we have repeated the IEPA/USEPA comments in this order and our response follows each comment.

INTRODUCTION

IEPA/USEPA Comment:

The general conclusions of this joint review can be summarized by stating that the assessment needs to be expanded..[sic] Downgradient and deep aquifer conditions are not adequately described. Both onsite and offsite sources of contamination have not been sufficiently identified. The severe groundwater contamination in [sic] an areawide problem. The study must be comprehensive in scope. The recommendations for remedial action are far too narrow. Many good possibilities for remedial action were unnecessarily discarded or not considered at all. Known contamination problems representing substantial risks to the public health and environment are dismissed. Comments contained in the following section support the aforementioned conclusions.

Geraghty & Miller, Inc. Response:

Geraghty & Miller, Inc. does not believe that the scope of the ground-water assessment it has conducted on behalf of Monsanto requires expansion because additional on-site work is not necessary. The preliminary study, combined with the well installation, aquifer testing, and sampling and boring programs, constitute a comprehensive study that has areally covered the entire plant site and has investigated all three hydrogeologic zones in the unconsolidated deposits and the bedrock. *Leads area is included*

The preliminary study included a thorough search of Monsanto, state and federal documents on the area; and a well inventory was conducted to determine whether or not wells within 1 mile of Monsanto's property are providing drinking water. The results of the Phase I study were used to develop the scope of work for the ground-water investigation on-site. Many of the 65 monitoring wells and approximately 20 soil borings were targeted in areas of known or suspected waste disposal. Other wells were drilled between the plant production area and Monsanto's western boundary to define general hydrogeologic conditions, including ground-water flow patterns and responses to changes in river level, and to determine how far contaminants may have traveled. Well drilling was done in phases so that each successive phase would rely on the data obtained in the previous one and data gaps could be filled. *1/2*

During our investigation, only three source areas of contaminants were identified. The W.G. Krummrich Landfill had been identified as an area that required investigation even before the Geraghty & Miller, Inc. study began. Approximately 45 wells have been installed in the landfill area including those wells installed by Geraghty & Miller, Inc. The Route 3 drum site was also identified, and this area was targeted for a comprehensive investigation. The only other area in which contaminants appear to have originated is the production area itself where there was the possibility, in the past, of diverse, but unidentifiable, potential sources such as old spills and sewers and tanks which may have leaked.

We agree with the IEPA's contention that ground-water contamination is an area-wide problem which may involve other properties in the Sauget vicinity. However, Monsanto has neither the responsibility nor the authority to carry on studies off-site on the properties of others. *What is the IEPA's position?*

Our recommendations for the remedial action were limited to addressing the potential sources of ground-water contaminants because (as the IEPA acknowledges on page five of its June 30, 1987 letter) direct ground-water remediation

is impractical. We also recommended natural attenuation because the ground-water contaminants do not constitute a health hazard and appear to have essentially no impact on the Mississippi River.

Monsanto has undertaken an aggressive program to reduce, to the maximum extent possible, contaminant loading to the ground-water system. We believe that all significant potential sources have now been identified. Remedial projects to deal with these sources have included the following:

1. Contributing to the construction of the new American Bottoms Regional Treatment Plant.
2. Upgrading the sewer system in the plant area to reduce exfiltration.
3. Stabilizing the river bank to protect the landfill from erosion.
4. Removing underground storage tanks.
5. Minimizing spills and leakage.
6. Decommissioning of the chlor-alkali and sulfuric acid plants.
7. Decommissioning the river terminal storage facilities.
8. Removing 30 drums from the South Lot Drum Site.
9. Capping of the Route 3 drum site.

Combined with the costs of the sewer projects being undertaken in the Village of Sauget, the costs associated with remedial projects will exceed \$30 million by 1989. The only area which remains to be addressed is the W.G. Krummrich Landfill.

In 1986, Monsanto authorized Geraghty & Miller, Inc. to undertake a long-term, ground-water monitoring program which is continuing. If the long-term monitoring data indicate that additional remediation is required in particular areas, appropriate actions will be taken.

#### CONCERNS ON GROUND-WATER FLOW

##### IEPA/USEPA Comment:

In reference to Geraghty & Miller's groundwater study of conditions at Monsanto's Krummrich Plant in Sauget; the stated conclusion of the study is that although the plant operations have affected groundwater quality, offsite impact is minimal because the aquifer dilutes the contamination to acceptable levels. This conclusion is both short-sighted and incorrect based on the following observations.

Figures 16 and 27, "Approximate Areas (of) Organic Compound Concentrations . . . on the Monsanto Property" demonstrate the limits of this study on

the groundwater contamination near the W.G. Krummrich Plant. Figures 26 and 27 (from Volume II of the Plant-Wide Assessment) outline the groundwater contamination in the shallow (Figure 26) and intermediate zone (Figure 27). A close look at these outlines reveals that the perimeters of the contamination plumes arbitrarily end at the Monsanto property line where Geraghty & Miller stopped their investigation. Apparently, the contamination plume in the shallow zone extends to the south of the Monsanto property and the plume in the intermediate zone extends to the south and west of the Monsanto property. These Figures [sic] do not reveal the full extent of the contamination.

A study of the report and Figures 26 and 27 will yield another conclusion [sic]. The contamination plume from Monsanto increases in areal size with depth. The increase in groundwater flow velocity with depth causes this increase in areal size of the contamination plume. Geraghty & Miller calculate a flow velocity in the deep zone of 300 times the velocity of the shallow zone. Because of its much higher velocity, the contaminated groundwater in the deep zone has certainly traveled far from the Monsanto property and maybe as far as the Mississippi River. The decrease in concentration with depth is caused primarily by the increase of aquifer flow in the deeper zones rather than a decrease in contaminant loading. The study neglects these facts. (See Appendix A)

The reversal of groundwater flow direction due to decreased pumping has probably had the effect of increasing contaminant concentrations offsite. When heavy pumping from the groundwater system was occurring in the past, it produced deep cones of depression near the sources of the pollutants. These deep cones of depression would have pulled pollutants out of the relatively impermeable shallow zone and into the more permeable intermediate and deep zones where they could travel faster and further. Some of these pollutants were removed by the heavy pumping which also would have tended to confine them near the cones of depression. However, when the pollutants in the groundwater became too much for the local users to bear, they quit pumping and allowed the contamination plumes to spread offsite. Geraghty & Miller did not address the effects of the history of groundwater use at the site on the vertical and areal extent of contamination. (See Appendix A)

The report on the Krummrich Plant stated that the affect [sic] of the contamination plume upon the region is minimal because few water supply wells are in the area. As few as fifteen years ago more than 20 MGD was being pumped from the aquifer. At present only 0.5 MGD is being pumped. The primary reason for the decrease of pumpage is regional deterioration in water quality. Groundwater contamination has had a profound effect upon the region. (See (Vol I. p 7) Appendix A)

Geraghty & Miller, Inc. Response:

As already indicated above, we believe that the contaminants originating in the plant area are not discharging to the Mississippi River. Contaminants originating in the landfill area are discharging to the river but, almost certainly, with no significant impact. This was what was meant by the offsite impact being minimal. In addition, the aquifer is not supplying potable water to anyone in the area and therefore ground-water contamination does not constitute a health hazard. The contaminants in the eastern plume appear to be confined to the Monsanto and the Village of Sauget properties, and, even though the contaminants are migrating westward, the plume appears to be in a state of equilibrium in which contaminant contributions (which are in the process of being reduced by source remediation) equal contaminant attenuation downgradient. Therefore, we do not expect a major alteration in the size of the area affected by the ground-water contaminants.

The IEPA is correct in its assertion that Figures 26 and 27 do not show the entire area affected by ground-water contaminants and that the contamination probably does not stop at the western property boundary. Data shows that between the Monsanto and Village of Sauget properties, in the general vicinity of the Mississippi River levee, concentrations of contaminants are extremely low; this indicates that the plume of contaminants arriving from the east (from the Monsanto and SSDRA properties) is not discharging to the Mississippi River. We are required to produce two separate reports for two separate clients and cannot make conclusions and recommendations about adjacent properties in individual reports. As the IEPA points out, it may be desirable to produce one map showing the results of both studies. Although this was not possible in these reports, it is necessary to consider the results of both studies in order to evaluate the total contamination situation. We hope that these comments and any subsequent discussions will aid in that joint evaluation.

With respect to Monsanto's southern boundary, we believe that the contamination shown at the Monsanto property boundary does indeed terminate at the southern property

line. This is because, prior to 1973, Monsanto's pumping almost certainly would have confined contaminants to the site in a large cone of depression created by its on-site wells. Between 1973 and 1980 (after the cessation of pumping), the flow direction shifted toward the west, and all of the ground water now migrates toward the Mississippi River. There is no evidence of any driving force that could have directed ground-water flow southward. If contaminants are present south of Monsanto's property, they probably originated from an off-site source.

The IEPA is also correct in its conclusion that the areal extent of contamination in the intermediate and deeper zones is larger than in the shallow zone. The reason for this, as indicated in the IEPA memorandum, is that onsite pumping prior to 1973 undoubtedly drew the contaminants from the shallow zone into the intermediate and deep zones where they travel at a faster rate than in the shallow zone. Contrary to the IEPA's assertion, however, we have not neglected this fact. It was one of the primary reasons why we recommended that no remedial pumping be undertaken as the remedial wells would have had to pump from the intermediate and deep zones which would have restarted the vertical migration from the shallow zone, where the contaminants are substantially isolated and move relatively slowly.

The IEPA conclusions regarding the reduction of major pumping in the Sauget area are not correct. Prior to the passage of the Clean Water Act, ground water was generally pumped and used in "once through" systems which discharged to the Mississippi River. After the passage of the Clean Water Act and other laws, Sauget Village began development of upgraded and expanded waste-treatment facilities. Because the size and, therefore, capital and operating costs of these facilities were and are directly related to flow, Monsanto and the other village industries could no longer afford to use large quantities of relatively clean "once through" cooling water. Most large users changed to cooling towers or other types of recirculation systems. Their decisions were based primarily on short- and long-term wastewater treatment economics rather than the contamination of the ground water, although naturally occurring iron and manganese fouling were also contributing factors.

#### IMPACT OF CONTAMINATION

##### IEPA/USEPA Comment:

1. The 77 lbs/day of organics discharged to the Mississippi River is a serious environmental release. This release equates to 14 tons/year. Even if the contaminants are diluted below detections limits in the water, this does not mean that the public health and environment are not affected. Bioaccu-

mulation of pollutants is a demonstrated fact and has occurred in Mississippi River fish. IEPA ran a computer search for chlorinated nitrobenzenes, one reference we found for these compounds came from a study conducted by FDA to determine residues of these compounds in fish (attached). This study reports residues of chlorinated nitrobenzenes up to about 1 ppm in Mississippi River fish, with the highest concentrations immediately downstream from Sauget. Furthermore, this study reports no chlorinated nitrobenzene residues in fish collected north of Sauget and detectable residues in fish as far as 150 miles downstream! It is possible that these residues may be coming from the discharge of Sauget's WWTP, and if this is true then this is another problem which should be addressed. However, we feel that the bulk of this fish contamination may be due to the ground-water contamination in and near the Krummrich Plant.

2. The chloronitrobenzenes found in the fish have many adverse health effects. Vinyl chloride, methylene chloride, pentachlorophenol and benzene found at the Sauget Treatment Plant [sic] Site are all carcinogenic. Similar compounds of public health concern have been found at the W.G. Krummrich Plant Site. The contamination of the ground-water and soil at these two sites are very difficult to dismiss as inconsequential. (See Appendix C and Appendix E)

Geraghty & Miller, Inc. Response:

The reported 77 pounds per day of organics discharging to the Mississippi River, is preliminary and probably worst case. It was based on ground-water gradients in existence at the time that dewatering wells were in operation in connection with the construction of the new American Bottoms Regional Treatment Plant, and it is also based on a limited amount of information from the deep aquifer. In the very near future, we will be revising this estimate after we measure natural ground-water gradients in the area and after we consider the analytical data which is expected from three new deep wells recently installed in the landfill for this purpose.

To date, Geraghty & Miller, Inc. has submitted no recommendations to Monsanto for remedial action at the W.G. Krummrich Landfill. Before such recommendations are submitted, an endangerment assessment will be conducted to determine what impact ground-water discharges along the river's edge are having on the Mississippi River. The endangerment assessment may entail a fish study, depending upon recommen-



dations made by a consultant who is an expert in endangerment assessments.

In any event, we do not regard the two studies attached to the IEPA letters of comments regarding fish contamination to be conclusive. Eight fish samples collected in a 150-mile stretch between St. Louis and Cape Girardeau is an extremely small population over so large an area, and we do not believe that the inventory of dischargers to the Mississippi River is complete. The study undertaken by Ellis et al. (1982) limited itself to the discharges from POTWs, with the exception of one industrial plant. Between Sauget and the confluence of the Mississippi and Missouri Rivers, there are probably several industrial dischargers, and at least one major POTW, which were not listed.

Even if the contaminants in Mississippi River fish originated in the Sauget area, it is virtually impossible to determine whether or not the source for the nitrochlorobenzenes was the landfill or the old Sauget POTW. The old Sauget POTW is in the process of being replaced.

Incidentally, we would like to receive a complete copy of the Yurawecz and Puma (1983) article for which we received only pages 1345 through 1351. In addition, we did not receive the appendices to which IEPA's letter refers and, therefore, cannot make a comment on this information.

#### EFFECT OF CONTAMINATION

##### IEPA/USEPA Comment:

Well, B-29, has a mean concentration of priority and non-priority pollutants in the shallow water zone of 1,393,000 ug/l and in the intermediate zone of 359,000 ug/l. A large proportion of these contaminants is phenol and dimethylphenol, which we could accept as being derived from facilities other than Monsanto's. However, there are also relatively large concentrations of chlorophenols, dichlorobenzenes, and nitrobenzenes, which we are fairly confident came solely from Monsanto's operations (either synthesis, use, or disposal at the Krummrich Plant). Finally, 2-nitrochlorobenzene and 4-nitrochlorobenzene were found in the tens of hundreds of thousands of ppb range in monitoring wells near B-29 (B-24 and B-25), and were reported as 124,000 ug/l total nitrochlorobenzenes for well B-29 (including 2-, 3-, and 4-nitrochlorobenzene). These compounds definitely came solely from Monsanto's operation.

Concerning the effects of the chlorinated nitrobenzenes: Two articles in Mutation Research

have reported some of these compounds to be mutagenic in the Ames assay and to induce DNA damage in several organs in vivo, especially the higher chlorinated compounds. The toxicity of these compounds appears to be related to the number and distribution of the chlorine and nitro groups on the benzene ring; common effects include methemoglobinemia and hemolytic anemia, skin irritation, kidney and liver damage, and CNS depression. The taste and odor thresholds for some of these chloro- and nitrochlorobenzenes is quite low, and the risk of death or permanent injury is high to very high after short exposure to small quantities for m- and p-chloronitrobenzene (from Sax, Dangerous Properties of Industrial Materials, 4th Ed., 1975). The 96-hour LC<sub>50</sub> for m-chloronitrobenzene is reported to be 1.2 ppm for bluegills.

Concerning benzene: Some of the monitoring wells for this investigation show high levels of benzene and chlorobenzene. Geraghty and Miller claim that the reported benzene and chlorobenzene levels are suspect because these compounds are found in the lab blanks. While it is true that benzene and chlorobenzene were found in the lab blanks, it seems that the high levels in the groundwater, especially for benzene, indicate that there is definitely a "true" benzene contamination at this site. This is further illustrated by the results reported for well GM-17, which shows the same high levels in the groundwater with no change over time (57,700 ug/l in November, 1984 and 56,500 ug/l in November, 1985). It seems unlikely to us that any lab error could result in so large and so consistent analytical levels of benzene at this monitoring well. This high level of benzene (a known human carcinogen) in groundwater discharging to the Mississippi indicates another problem in this area which probably should be addressed.

Geraghty & Miller, Inc. Response:

Well clusters B-25 and B-29 are located about 20 ft from the property line between the Monsanto landfill and the adjacent property containing the old Sauget landfill. The contaminants mentioned may or may not have come from Monsanto's operation, depending upon where they were disposed and who deposited them.

As indicated above, an endangerment assessment is to be conducted to determine the impact that ground-water discharges are having on the Mississippi River. Toxicological discussions mean little without direct reference to actual

exposure levels, receptors and resultant hazard analysis. All this will be provided in the endangerment assessment.

The comments made by IEPA with respect to benzene found in Well GM-17 appear to be incorrect because the agency has misinterpreted our discussion of the chlorobenzene and benzene that were found in the blanks. At no time did we suggest that levels of 57,700 ug/L in November 1984 or 56,500 ug/L in November 1985 are low levels. These are significant concentrations. Our discussion in Volume I of the ground-water report about low levels of these compounds in blanks was simply meant to indicate that concentrations of about 5 ug/L or less are not representative of ground-water contamination (see page 29 of Volume I).

COMMENTS FROM IEPA LETTER DATED AUGUST 3, 1987

IEPA/USEPA Comment:

There are numerous wells in the northwest corner of the Monsanto Toxic Site adjacent to the Mississippi River. Monsanto is involved with mercury processing at this time and during the time of filling the deposit area. Wells GM, 39, 40, 41, 42, 44, and 47 as well as Borings 35 and 37 show no metal analysis. This information would be helpful to all parties.

Geraghty & Miller, Inc. Response:

Wells 39 to 42, 44, and 47 and Borings 35 and 37 are in the easternmost section of the main plant area, not in the W.G. Krummrich Landfill area.

IEPA/USEPA Comment:

The agencies appreciate SSDRA's and Monsanto's present need to separate the two separate documents and related maps into two completely separate entities. However, this effort does cause delays and some interpretation difficulties for individuals responsible for reviewing and generating comments to you. It's our suggestion that future documents and maps be generated with a holistic approach. Because adjacent industrial tracts show similar geological and hydrological properties and problems, those properties should be shown on one Master Plan Sheet and in one document. This would also eliminate a great deal of repetition.

Geraghty & Miller, Inc. Response:

As we have already indicated, a combined map might be desirable but the Monsanto Company and the SSDRA are two separate clients and, as such, require separate reports. Therefore, we cannot combine the data into one document. However, this does not preclude a joint evaluation of the

reports. We hope that these comments and any subsequent discussions will aid in that joint evaluation.

### REMEDIAL MEASURES

#### IEPA/USEPA Comment:

1. Additional study of the Monsanto sites is needed. Only a few of the sources of contamination have been adequately identified. The areal extent of groundwater contamination plumes has not been adequately charted especially to the west of the site and in the deep zone. The study concludes that offsite sources have contributed to groundwater contamination under the sites but cannot identify [sic] these sources. (See Appendix A, Appendix B, Appendix H and Appendix I)
2. Additional remedial measures [sic] must be considered. Geraghty & Miller rule out incineration as a remedial measure for the Monsanto Properties. They claim that incineration is too expensive and will expose the public to air pollutants. They claim that worker risk while excavating wastes or contaminated soil would be too high. Regulatory agencies at all levels of government, the public in many different areas, and many industries have found excavation and incineration to be the optimum remedial alternative as a final solution for cleaning-up contamination. It is difficult to understand how such a common and reliable remedial option becomes impossible when applied to these two sites. (See Appendix E, Appendix I and Appendix G)
3. River stages affect both groundwater elevation and direction. High river levels can reverse groundwater flow direction and could raise the uppermost aquifer well into highly contaminated areas. This situation would complicate any containment scheme as a remedial measure. (See Appendix C, Appendix E and Appendix G)

With respect to clean-up of the contamination, the study's recommendation, that remedial action is not practical, is probably correct. Not because it is unjustified, but because once a [sic] aquifer has been contaminated to such a widespread degree, the aquifer is lost to any useful development. This is not to say that no response is necessary. The elimination of the sources of groundwater contamination must be aggressively pursued until the natural order of the aquifer is restored.

The dilution affect [sic] of the aquifer upon the pollutants is not an acceptable disposal vehicle for Monsanto's intentional or unintentional discharges [sic] of pollutants into the groundwater. Current projects targeted to eliminate potential pollutant sources are only as adequate as their effectiveness in decreasing the pollution loading upon the aquifer. A comprehensive ground-water monitoring program should be instituted to document future fluctuations in pollutant concentrations. Additional wells may be necessary to chart concentrations accurately to the west of the plant and in the deep aquifer zone. The properties adjacent to Monsanto should be enjoined to complete a regional groundwater monitoring system. And finally a contingency plan should be instituted based upon the results of the monitoring program. The plan would state what additional pollutant-source abatement projects are required to eventually allow the aquifer to return to its natural state.

Groundwater contaminants at the W.G. Krummrich Plant were once captured in cones of depression and removed by pumping. A similar system could be implemented as a groundwater remediation measure. The plant uses and no doubt treats river water. Substituting the pumping and treating of contaminated groundwater for use in the plant would be a remedial measure with two virtues. The first would be that substituting treatment of groundwater for the treatment of river water would help offset the costs. Because the plant uses large amounts of water, and will hopefully be in production for many years, the requirement that large quantities of groundwater be removed and treated will be met. The second virtue is the inherit [sic] fairness of Monsanto returning to use the groundwater resource that they abandoned due to their own pollution and thereby helping restore its original quality.

Geraghty & Miller, Inc. Response:

As we have already indicated, the areal extent of ground-water contamination has been adequately determined. The IEPA's comment that the plume has not been charted adequately to the west is correct only if the Monsanto report is reviewed alone. This perceived difficiency can be corrected by considering both the Monsanto and the SSDRA reports together. Monsanto is not in a position to define off-site sources which may be contributing to the ground-water contamination on Monsanto's property because Monsanto has neither the responsibility nor the authority to undertake studies on adjacent properties. (In this regard it is essential for us to be able to review Appendices A, B, H, and I to which the IEPA memorandum refers.)

With respect to remedial measures, our ground-water report addresses only potential remediation for ground water. The incineration mentioned on page five of the IEPA memorandum is not appropriate for ground water, and we presume the agency was referring to the Route 3 Drum Site and/or the W.G. Krummrich Landfill in its discussion of incineration. We have already submitted a special report on the Route 3 Drum Site which explains why incineration was ruled out. In response to the continued IEPA concerns, we have also agreed to submit an even more detailed explanation of the remedial alternative selection procedure. This explanation is scheduled to be submitted in January 1988.

Geraghty & Miller, Inc. has not submitted recommendations to Monsanto regarding remedial action at the W.G. Krummrich Landfill. Although we certainly intend to include incineration in an initial screening of alternatives for the landfill, we would like to point out that incineration is not the only or even the best remedial alternative in all cases. With respect to the W.G. Krummrich Landfill, incineration is not a feasible or acceptable alternative for several reasons.

First, incineration is not technically feasible due to the very close proximity of the landfill to the Mississippi River (200 ft at the closest point). There is no feasible way to excavate material without river water infiltration at high river levels (which occur almost yearly).

Secondly, excavation and incineration would result in increased human environmental exposure. In addition to air exposure from incinerator upsets, start-ups, and shutdowns when incomplete incineration can occur, a river flood could cause tons of contaminated wastes to be washed from the site and carried downstream from an open pit. In addition, an open pit would probably cause vertical migration of contaminants, thus increasing contaminant concentrations in the intermediate and deep zones. This, in turn, could increase the impact on the Mississippi River from increased ground-water discharges.

The incineration alternative is not cost-effective. The landfill contains an enormous quantity of material, perhaps as much as 750,000 to 1 million cubic yards ( $\text{yd}^3$ ). Even if it were possible to burn 25,000  $\text{yd}^3$  per year, which is a fairly large quantity, it would take between 30 and 40 years to incinerate such an amount. The costs of such an operation would be in the vicinity of \$25 million per year. Over a period of 30 or 40 years, the costs would be between \$750 million and \$1 billion. These cost estimates were based on a recent article in the November 12, 1987 Engineering News Record, which describes the proposed on-site incineration of 25,000  $\text{yd}^3$  of material at the Love Canal.

Even if ground-water remediation were practical (and it appears that it is not, as acknowledged by IEPA on page five of its June 30, 1987 letter), our study indicates that ground-water contamination is neither a health hazard nor a risk to the environment. Given the technical problems associated with remediation, the best approach is to allow the plume to attenuate naturally and, at the same time, take aggressive action to eliminate additional loading to the ground-water system. The only possible remedial alternative for ground water (i.e., pumping and treating) is both impractical (because of the large quantities of water that would have to be exchanged in the aquifer) and undesirable (because it could only be done from the intermediate and deep zones which would simply draw contaminants, now substantially isolated in the shallow zone into the deeper zones where contaminant migration velocities are much greater). The difficulties associated with ground-water remediation are fully explained in Geraghty & Miller, Inc. (1986), Volume II.

If you have any questions or require additional information, please do not hesitate to contact us.

Sincerely

GERAGHTY & MILLER, INC.

*Nicholas Valkenburg*  
Nicholas Valkenburg  
Associate

NV:dv